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(54) Disturbance detection in a data signal

(57) Disturbance detection is used to detect anomalies in the behaviour of the data signal. The data signal may for example be a readout signal in an optical drive. An upper and a lower envelope signal value for the data signal (4) are determined in a determined time interval (Δ(m - 1)). During the following time interval (Δ(m)) a difference value is computed by substracting from each other the values of the lower (s7) from the upper (s6) envelope signals. A disturbance is detected in case the difference value is smaller than a predetermined border value (5).

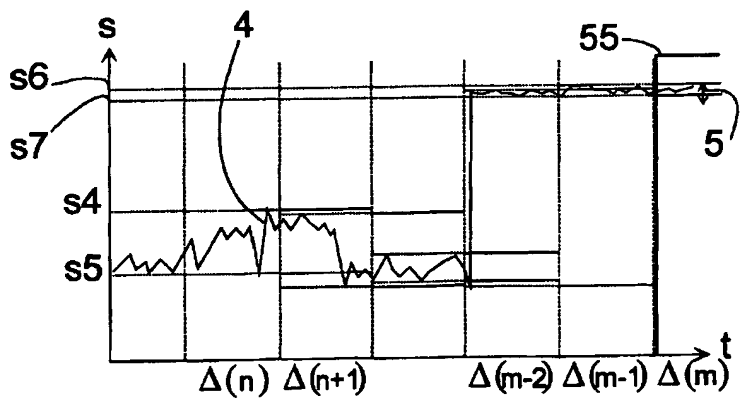

FIG. 2

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Description

[0001] The invention relates to the field of disturbance detection in a data signal.

[0002] Disturbance detection in a data signal is used to detect anomalies in a behaviour of the data signal. The data signal may for example be a readout signal in an optical drive (CD, DVD, ...) or any other type of data reading device. Disturbance detection is required to initiate a freeze of some parts of a data acquisition and servo processing system while data is not usable due to for example black dots, scratches, silverdots or fingerprints on a data carrier. It is advantageous to recognize disturbances as fast as possible in order to fix the data acquisition and to release it again afterwards.

[0003] The data signal has a dynamic behaviour which may be confined between an upper and a lower envelope. In case of a disturbance in the data signal the dynamic behaviour is modified and a difference value which is equal to the substraction of the values of the upper and lower envelope between each other may become smaller than a predetermined border value. Monitoring the difference value allows to determine whether it is smaller than the predetermined border value in which case a disturbance in the data signal is detected.

[0004] The upper envelope may for example be set to a value equal to a value of the data signal if the value of the latter is greater than the upper envelope value. If during a determined period of time the upper envelope value has not been increased then it may be decreased by a fixed value.

[0005] The lower envelope may in a way similar to the upper envelope be set to a value equal to a value of the data signal if the value of the latter is smaller than the lower envelope value. If during a determined period of time the lower envelope value has not been decreased then it may be increased by the fixed value.

[0006] Hence if the data signal is disturbed, e.g. it adopts a relatively low dynamic behaviour, the upper and / or lower envelope values tend to approach the data signal value and the difference value becomes smaller than the predetermined border value. A time laps in which the upper or lower envelope values reach a value near to the data signal value depends on the determined period of time, as the upper or lower envelope values may vary linearly. The time laps has a variable length depending on a number of parameters which will not be discussed here, and appears to be relatively long in most cases of disturbance. As a consequence the detection of the disturbance, which is done after the time laps, is delayed by a relatively long and variable time following the effective occurrence of the disturbance.

[0007] It is an object of the present invention to reduce the time laps occuring between a disturbance in the data signal and the detection of the disturbance.

[0008] It is another object of the present invention to have a time laps of a determined length between the disturbance and the detection of the disturbance.

[0009] A solution to the described problem is according to the invention seen in a method for detecting a disturbance in a data signal comprizing

- obtaining a lower and upper envelope signal for the data signal,
- computing a difference value by substracting from each other values of the lower from the upper envelope signals,
- determining a disturbance if the difference value is smaller than a predetermined border value, and
- setting the values of the lower and the upper envelope signal equal to respectively a minimum and a maximum value of the data signal taken in a determined time interval.

[0010] Another solution to the described problem is according to the invention seen in a device for detecting a disturbance in a data signal comprizing

- an envelope generator, an input of which receives the data signal,
- a defect signal generator which receives through at least one input signals representive of an upper and a lower envelope generated by the envelope generator,
- a register interface which outputs to the envelope generator a signal representative of a predetermined time interval and to the defect signal generator a signal representative of a predetermined border value, the envelope generator giving to the upper and lower envelope value respectively a maximum and a minimum value of the data signal received in the predetermined time interval, and the defect signal generator computing a difference value by substracting the lower from the upper envelope and outputting a defect signal if the difference value is smaller than the predetermined border value.

[0011] In the following, examples of carrying out the invention will be described referring to drawings, wherein

- Fig. 1 contains a graph of an upper and lower envelope signal to illustrate a prior art solution,
- Fig. 2 contains a graph of an upper and lower envelope signal to illustrate the invention,
- Fig. 3 contains a block diagram of a device according to the invention.

[0012] The graph in Fig. 1 comprises on one axis a time scale t and on another axis a data signal value scale s. A curve 1 and a curve 2 represent respectively an upper and a lower envelope of a data signal (not shown) as known from prior art. A value of the data sig-

nal is at all times comprised between the curves 1 and 2.

[0013] The values in curve 1 are set equal to a value of the data signal if the latter is greater than the former. If during a determined time interval Δt the value in curve 1 has not been increased then it is decreased by a fixed value Δs. If during a plurality of consecutive determined time intervals Δt the value in curve 1 was decreased by the fixed value Δs, this results in a linear decrease of the values in curve 1 as is shown in a time laps T of the curve 1. Hence if at a moment t1 the value in curve 1 drops from s1 to s2, then the time laps T required for the value of the curve 1 to decrease from s1 to s2 is at least $T = (s1 - s2) . \Delta t / \Delta s$.

[0014] The values in curve 2 are set equal to the value of the data signal if the latter is smaller than the former. If during the determined time interval Δt the value in curve 2 has not been decreased then it is increased by a fixed value Δs. During the time laps T in Fig. 1 the values in curve 2, which are at all times smaller than the values of the data signal (not shown) decrease to a value s3 smaller or equal to s2, which is the value of curve 1 at the end of the time laps T.

[0015] After the time laps T a defect signal 3 is generated which indicates that a disturbance in the data signal has occured. The defect signal 3 is generated whenever the difference value $\Delta d = s2 - s3$ is smaller than a predetermined border value b, i.e., $\Delta d < b$.

[0016] The curves 1 and 2 may be obtained for a data signal which is a high frequency signal after readout of an optical disk, e.g., a Compact Disk, a magneto-optical disk or a Digital Versatile Disk. The disturbance which causes the HF to decrease in value and in its dynamic behaviour at the beginning of the time laps T, and the curve 1 to decrease from s1 to s2 during the time laps T may be caused by a black dot pattern on a track of the disk being read. The intensity of light reflected by a black dot pattern is relatively low and the value of the resulting HF signal is decreased to relatively small values.

[0017] Other causes for disturbances in an HF signal may for example be a scratch, a silverdot (relatively high values of the resulting HF signal) or fingerprints on the track being read.

[0018] The data signal may for example be a sampled HF signal, i.e., a HF signal for which discrete values are obtained at time intervals. In this case the predetermined time intervals Δt may comprise a determined number of HF signal samples.

[0019] The graph in Fig. 2 comprises on one axis a time scale t and on another axis a data signal value scale s. A curve 4 represents the value of the data signal at the time t. The time scale t is divided in time intervals $\Delta(n) = \Delta(n + 1) = ... = \Delta(m)$, n and m being integers and a value of such a time interval being equal to a determined time interval which may be adjusted depending on the required performance. According to the invention a maximum s4 of the values of the data signal in the time interval $\Delta(n)$ is given to the upper envelope, and a minimum s5 of the values of the data signal in the time interval $\Delta(n)$ is given to the lower envelope. A difference value $\Delta d(n + 1) = s4 - s5$ of the upper and lower envelope values is subsequently computed, for example during the time interval $\Delta(n + 1)$.

[0020] New upper and lower envelope values are determined for each time interval and their difference value computed subsequently during the next time interval. The difference value is compared to the predetermined border value b in order to determine a disturbance in the data signal is the difference value is smaller than the predetermined border values b.

[0021] During the time interval $\Delta(m - 2)$ a disturbance in the data signal occurs resulting in an increase of the data signal value. Such a disturbance may for example be caused by a silverdot pattern on the track of the disk being read.

[0022] During the time interval $\Delta(m - 1)$ the data signal exhibits a dynamic behaviour which makes it appear relatively stable. The upper and lower envelope values are set to s6 and s7 respectively. During the time interval $\Delta(m)$, the difference value $\Delta d(m) = s6 - s7$ is computed and compared to the predetermined border value b which is represented in Fig. 2 using a double arrow 5 for reasons of better understanding only. Since $\Delta d(m) < b$ a defect signal 55 is generated indicating that a disturbance has occured in the data signal.

[0023] The defect signal 55 is thus generated in the time interval following the time interval $\Delta(m - 1)$ during which the data signal has reached its relatively stable high value. No delay due to a linear increase of the lower envelope value as is known from prior art occurs, and as a consequence the delay between the generating of the defect signal and the occurrence of the disturbance is shortened as compared to prior art. The shortest delay may be obtained if the value of the time interval is chosen to comprise a rise time of the data signal from a usual value, like for example its value in time intervals $\Delta(n)$ and $\Delta(n + 1)$, to a relatively high disturbance value in $\Delta(m - 1)$. In this case the delay to generate the defect signal may be comprized between one and two time intervals.

[0024] Besides disturbances due to silverdots the invention may of course also be used to detect disturbances caused by black dots, scratches, fingerprints and others as in prior art.

[0025] The block diagram in Fig. 3 shows an envelope generator 6 which at an input 7 receives an HF data signal and at an input 8 a signal representative of the determined time interval from a register interface 9. The envelope generator outputs an upper and a lower envelope signal 10 and 11 respectively. The upper and lower envelope values are equal respectively to the maximum and the minimum of the HF data signal in the predetermined time interval. The envelope signals 10 and 11 are input to a defect signal generator 12. The latter receives at an input 14 from the register interface 9 a signal rep-

resentative of the predetermined border value b. The defect signal generator computes the difference value from the upper and lower envelope values and compares the difference value to the predetermined border value b. If the difference value is smaller than the predetermined border value then a disturbance is determined indicating that a disturbance in the HF data signal has occured, and the defect signal generator 12 produces at an output 13 a defect signal.

Claims

1. A method for detecting a disturbance in a data signal comprizing

   - obtaining a lower (2 ; s5, s7) and an upper (1; s4, s6) envelope signal for the data signal (4),
   - computing a difference value by subtracting from each other values of the lower from the upper envelope signals,
   - determining a disturbance if the difference value is smaller than a predetermined border value (5),
   characterized in that it comprises
   - setting the values of the lower and the upper envelope signal equal to respectively a minimum and a maximum value of the data signal taken in a determined time interval (Δ(n)...Δ(m)).

2. A method for detecting a disturbance in a data signal according to claim 1, characterized in that the computing of the difference value is done in a time interval (Δ(m)) subsequent to the determined time interval (Δ(m - 1)).

3. A method according to either one of claims 1 or 2, characterized in that the determined time interval and subsequent time intervals are taken to be of equal length.

4. A device for detecting a disturbance in a data signal comprizing

   - an envelope generator (6), an input (7) of which receives the data signal,
   - a defect signal generator (12) which receives signals representative of an upper (10) and a lower (11) envelope generated by the envelope generator,
   - a register interface (9) which outputs to the envelope generator a signal representative of a predetermined time interval (8) and to the defect signal generator a signal representative of a predetermined border value,

   the envelope generator giving to the upper and lower envelope value respectively a maximum and a minimum value of the data signal received in the predetermined time interval, and the defect signal generator computing a difference value by subtracting the lower envelope from the upper envelope and outputting a defect signal (13) if the difference value is smaller than the predetermined border value.

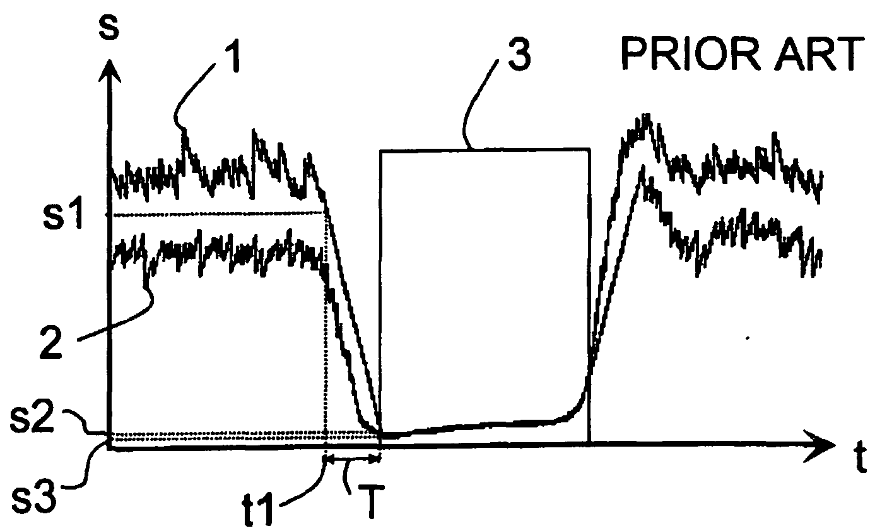

FIG. 1

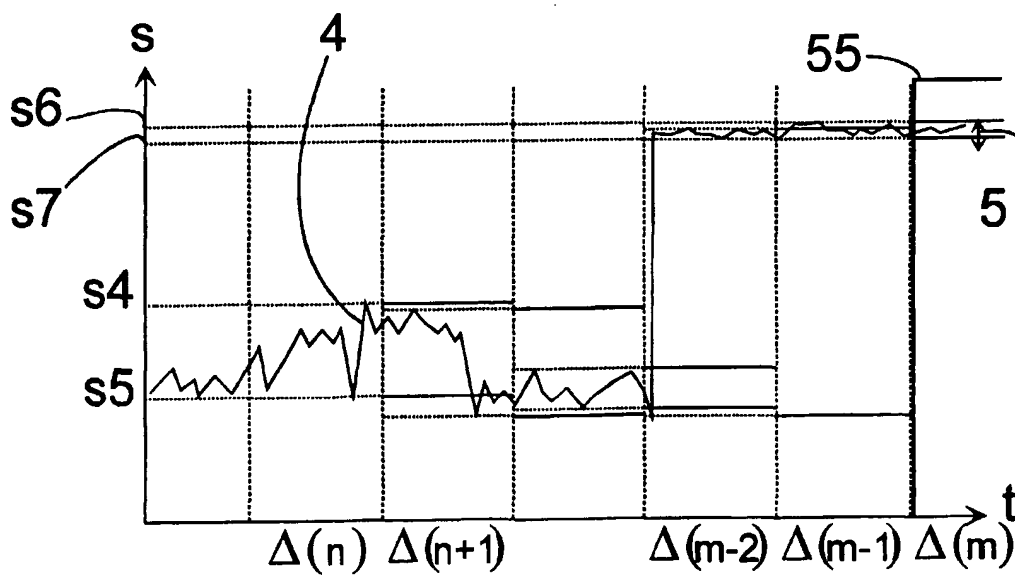

FIG. 2

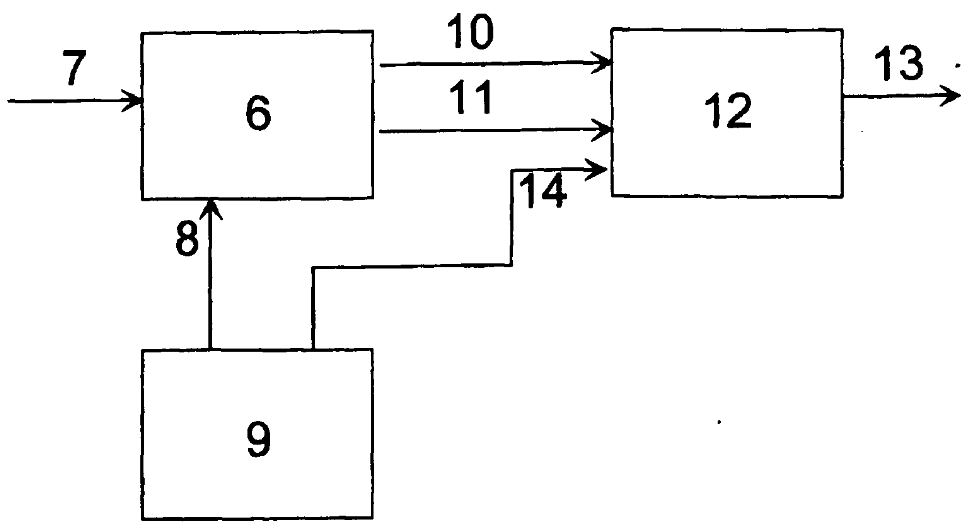

FIG. 3

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EUROPEAN SEARCH REPORT

Application Number
EP 98 40 2335

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A	EP 0 283 299 A (NIPPON TELEGRAPH & TELEPHONE) 21 September 1988 * column 3, line 7 - line 25 * * column 3, line 38 - line 48 * * column 6, line 27 - column 7, line 12 * * column 7, line 58 - column 9, line 54 * * column 10, line 64 - column 11, line 15 * * figures 3,5-8,12 * ---	1,4	TECHNICAL FIELDS SEARCHED (Int.Cl.6) G11B
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	29 January 1999	Schiwy-Rausch, G

CATEGORY OF CITED DOCUMENTS

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